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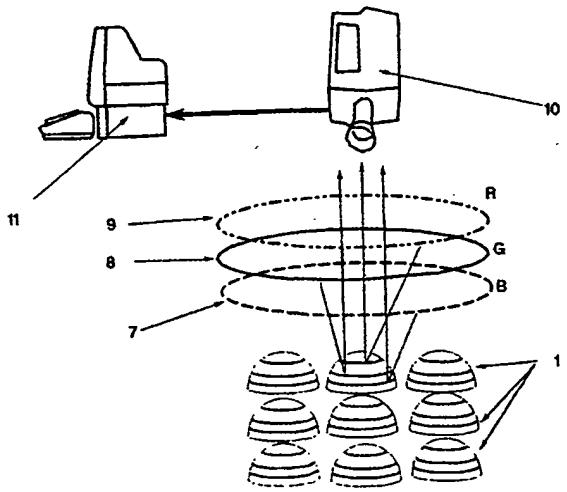
(54) Title: A METHOD AND SYSTEM FOR MEASURING BUMPS HEIGHT



(57) Abstract: The invention relates to a method and system for measuring the height of bumps or comparing bumps on a chip wafer. The method comprises the following steps: (a) projecting light, using a circular source of light, onto the bump at least twice at different angles of projection; (b) measuring the visible rings of light reflected by the bump at each different projected angle from a perpendicular viewpoint; (c) calculating the height of a bump or comparing the height of bumps, according to the extent of the visible change in the size of the reflected light rings and the projected angles. The system is comprised of three circular sources of light wherein each source is located at a different height and projected at a different angle and wherein each source projects a different color: red, green or blue. The system includes a camera for photographing the image of the visible reflected light rings from a perpendicular viewpoint. The processing unit in the system uses image-processing software to compare the bumps' height according to the difference in diameter between each color of the visible light ring, which is reflected from each bump.

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A METHOD AND SYSTEM FOR MEASURING BUMPS HEIGHT

The present invention relates to the field of measuring the height of small objects, and, more specifically, of three dimensional objects by using two dimensional techniques.

The present invention is a method for measuring the height of small objects and a system for using the same. The method and the system are useful for measuring the height of bumps and comparing bumps on a chip wafer, during the quality control process.

A "bump" is a half sphere shaped salient, made of solderable material, located on the face of a microelectronic chip. The bump exists in some chips and substitutes as leads by means of which the component is connected to the printed circuit when the bumps are soldered to the board. The bump shape is a half ball alike. A chip can contain a large number of bumps, which should be of the same height in order to connect all of them to the board at the same time. Actually, there are differences between the heights of the various bumps, as a result of the production process. Only small height differences can be allowed, and these must be within the tolerance limits. Therefore the height of each bump must be checked.

The present invention is a method and system for measuring the height of bumps or comparing bumps on a chip wafer.

To indicate the bump height, a light is projected onto the bump and the bump reflects the light. Since the bump's contours are radial, the reflecting angle is changed according to the highest point on the bump's surface and this angle will depend on the angle of the projected light. To a given angle of light projection, there is only one point on the given bump contours where the reflection is perpendicular to the bump base. When the light source is circular, a ring of reflected light can be seen from the perpendicular viewpoint.

Bumps with different heights have different contours and different points of perpendicular reflection for the same projected angle. Changing the angle of the projected light changes both the perpendicular reflecting point and the diameter of the said reflected light ring. The extent of the change in the reflected light ring diameter depends on the height of the bump. Therefore, the extent of the change of the ring's diameter at no less than two angles of projection enables the bump height to be calculated and a comparison of the height of neighboring bumps to be made when light is projected onto neighboring bumps at the same time.

Instead of projecting the light two or three times, each time from a different angle, different colored lights can be projected. When using image processing the basic colors are preferred and the three basic colors are projected: red, green and blue.

The present invention, as stated above, includes both a method and a system.

The present invention includes a method for measuring the height of bumps or comparing bumps, comprises the following steps:

a) Projecting light, using a circular source of light, onto the bumps at least twice with different angles of projection, or once with different colored lights, each colored light being projected from a different angle;

b) Measuring the visible rings of light reflected by the bumps at each different projected angle or in each different color from the perpendicular viewpoint;

c) Calculating the height of bumps or comparing their height, according to the extent of the visible change in the size of the reflected light rings and the projected angles.

The present invention also includes a system for comparing the height of microelectronic component bumps. The system comprised of three circular sources of light wherein each source is located at a different height and projected at a different angle and wherein each source projects a different color: red, green or blue. The system includes a camera for photographing the image of the visible reflected light rings from a perpendicular viewpoint. The processing unit in the system uses image-processing software to compare the bumps' height according to the difference in diameter between each color of the visible light ring, which is reflected from each bump. The results are displayed on a screen.

The three light sources of the system can be raised or lowered to obtain an optimal image of the reflected light rings. The camera in the system can be a digital camera, a video camera or any other camera.

The method and the system, according to the present invention, can also be used for quality control of chips on a wafer.

The present invention is shown in detail in figures 1, 2 and 3.

Figure 1 shows the method of measuring the height of a bump.
Figure 2 shows the reflected light rings.
Figure 3 shows the system for comparing bump heights.

Figure 1 shows the method of measuring the height of bumps. The figure describes the case of using two different colored lights. Two light sources project light onto the bump (1). The first circular light source (2a) projects light onto the bump at the first projected angle (4a). From the perpendicular viewpoint (5a) a reflected light ring (3a) is seen. The second circular light source (2b) projects light onto the bump at a second projected angle (4b). From the perpendicular viewpoint (5b) a second reflected light ring (3b) is seen. There is a difference between the sizes of the diameter of each of the two reflected rings. The change in size of the diameters and the projected angle enable the bump's height to be calculated.

Figure 2 shows the reflected light rings. Figure 2A shows the reflection of the higher bump and figure 2B shows the reflection of the lower bump. The bump (1a) is higher than the neighboring bump (1b). Light is projected from two sources onto both the bumps at a different projected angle. From the perpendicular viewpoint, the outer reflected light rings (3a) seem alike, but the inner reflected light rings (3b) are significantly different. The diameter of inner ring of the lower bump is smaller then the diameter of inner ring of the higher bump.

Figure 3 shows the system for comparing the height of bumps. The system compares the height of a number of neighboring bumps (1). The system comprises three light sources, a red light source (9), a green light source (8) and a blue light source (7). Each source projects light onto the bumps at a different angle. The light sources can be raised or lowered to obtain an optimal image in the camera (10). The camera is located so that it has a perpendicular viewpoint and the resulting image comprises triplets of reflected light rings, each triplet being comprised of the three reflected colors: red, green and blue. The camera transfers the image to the computing unit (11) that compares the height of the bumps, according to the diameters of the rings of each triplet, and marks the differences exceeding those of a predetermined tolerance. The results can be reported or displayed by means of any output media.

CLAIMS

1. A method for measuring the height of bumps or comparing bumps comprising the following steps:
   a) Projecting light, using a circular source of light, onto the bump at least twice at different angles of projection;
   b) Measuring the visible rings of light reflected by the bump at each different projected angle from a perpendicular viewpoint;
   c) Calculating the height of a bump or comparing the height of bumps, according to the extent of the visible change in the size of the reflected light rings and the projected angles.

2. A method for measuring the height of bumps or comparing bumps as claimed in claim 1 wherein at least two lights of different colors are projected at different angles at the same time instead of two white lights being projected at least twice.

3. A system for comparing the height of microelectronic component bumps comprising three circular sources of light wherein each source is located at a different height and projected at a different angle and wherein each source projects a different color, for example: red, green and blue, a camera for photographing the image of the bumps' visible reflected light rings from a perpendicular viewpoint, a processing unit using image-processing software to compare bumps' height according to the triplet visible diameters of each bump and means to report or display the results.

4. A system for comparing the height of microelectronic component bumps as claimed in claim 3 wherein each light source can be raised or lowered to obtain an optimal image.

5. A system for comparing the height of microelectronic component bumps as claimed in claims 3 or 4 wherein the camera is a digital camera.

6. A system for comparing the height of microelectronic component bumps as claimed in claims 3 or 4 wherein the camera is a video camera.

7. A system for comparing the height of microelectronic component bumps as claimed in claims 3 to 6 when it is used for quality control of chips on a wafer.

8. A method and system for measuring or comparing chip bumps, as described in the accompanying drawings.

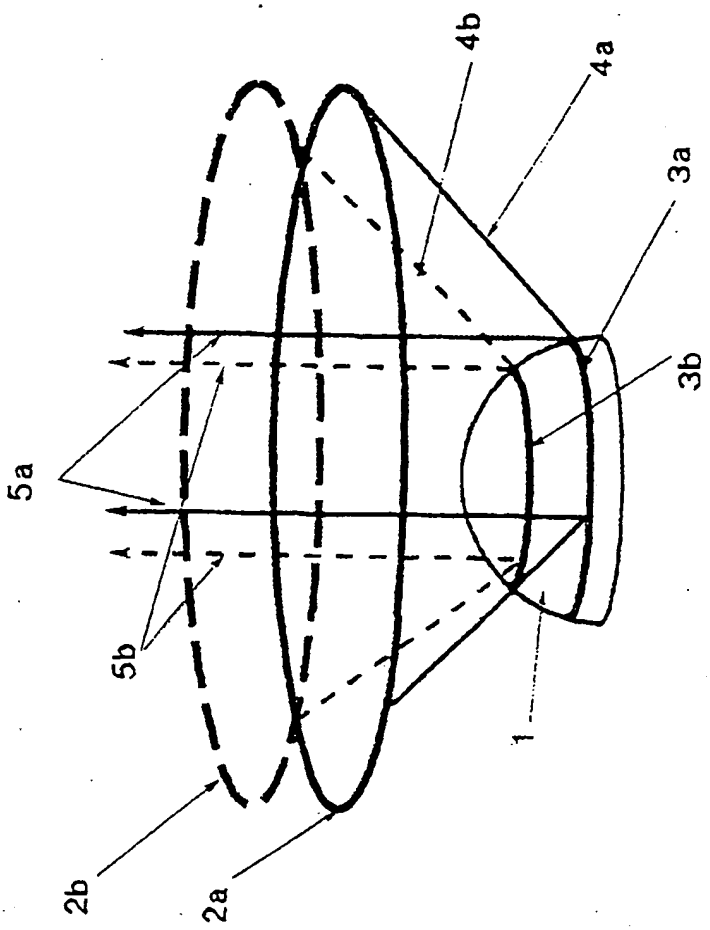

FIGURE 1

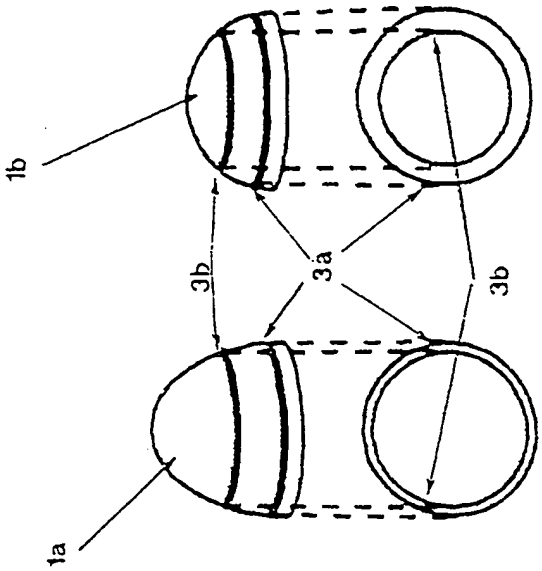

Fig. 2B

Fig. 2A

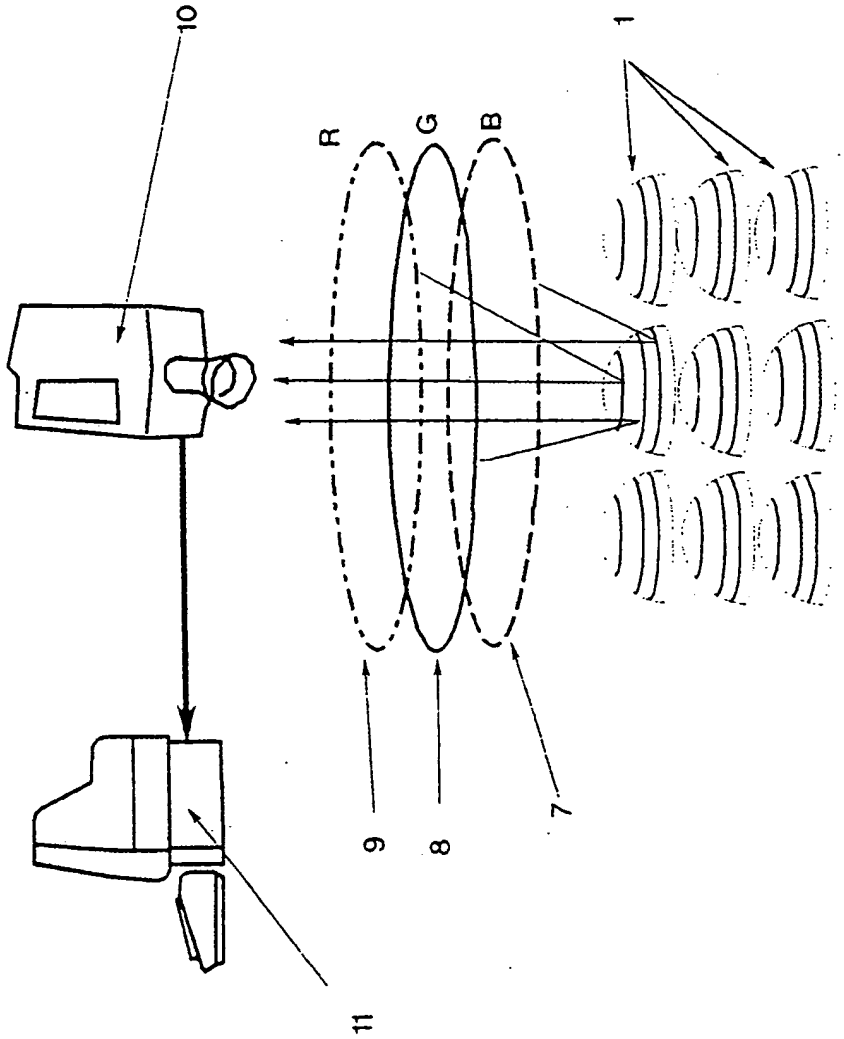

FIGURE 3